

La progettazione illuminotecnica: luce naturale ed artificiale, suggestioni ed applicazioni

IEA EBC Annex 90 - Luce naturale per gli obiettivi di decarbonizzazione e per ambienti di qualità

Roma, 3 giugno 2024

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Faculty of Engineering (LTH)

Lund University, Sweden



Affiliato ai gruppi di:

- Energy and Building Design
- Environmental psychology



Didattica

Energy-efficient and Environmental Building Design - Master's Programme

Master's programme - 2 years - 120 credits

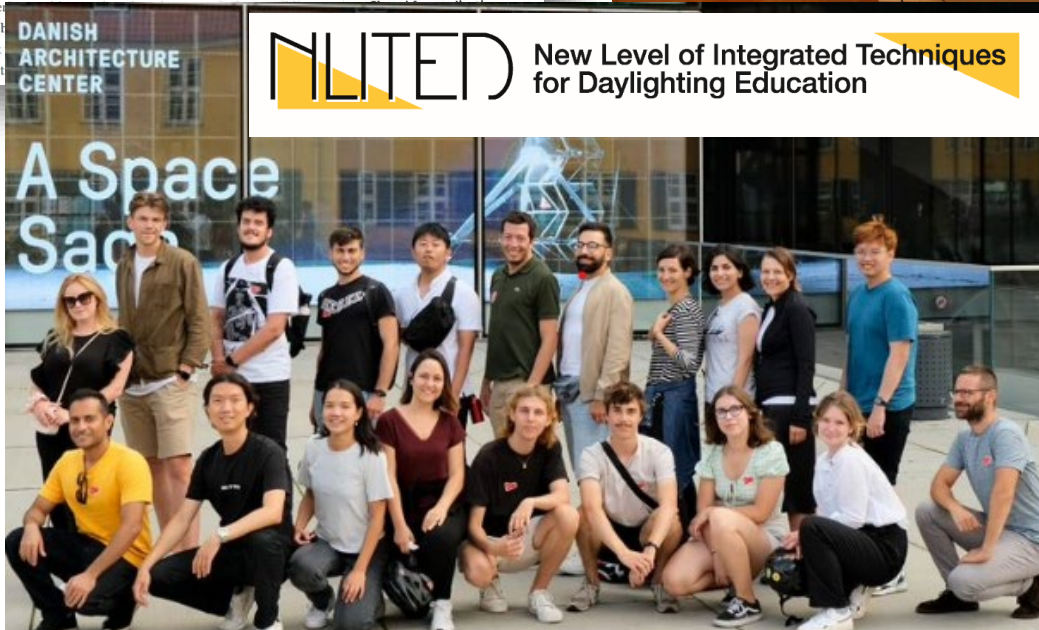


On this page:

Overview

Requirements and selection

A programme for those with a Bachelor's degree in architecture, civil engineering, or related fields. The programme focuses on sustainable building design, energy efficiency, and environmental impact. It includes coursework, practical experience, and a thesis project. The programme is designed to prepare students for careers in sustainable building design and environmental engineering.



NLITED Summer School 2024

Lund 17-24 Agosto 2024 – per professionisti e studenti

Iscrizioni aperte fino al 15 giugno su www.nlited.eu



 *Bertil & Britt Svenssons
Stiftelse för Belysningsteknik*



Federica Giuliani



Mandana S. Khanie



Natalia Sokół



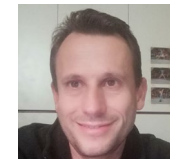
Niko Gentile



Pimkamol Mattsson



Luca Zaniboni



Valerio Lo Verso

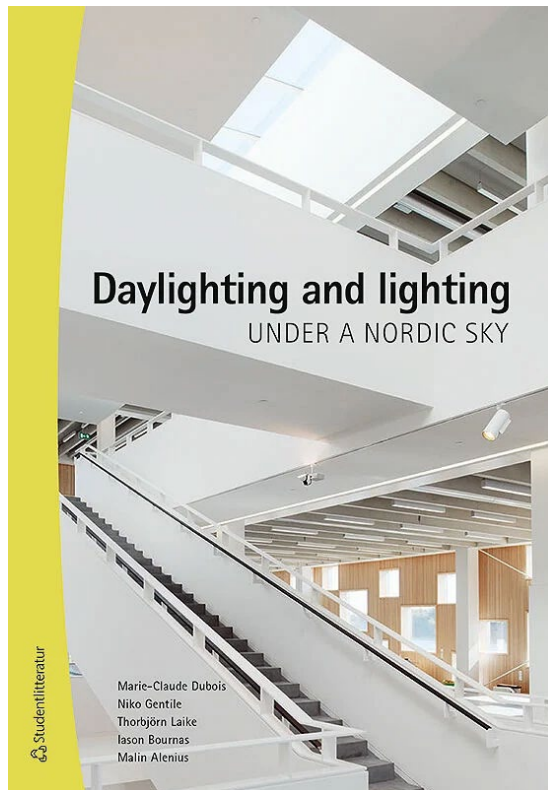
IEA EBC Annex 90 - Luce naturale per gli obiettivi di decarbonizzazione e per ambienti di qualità



Didattica e ricerca

Un libro per architetti ed ingegneri

Disponibile su richiesta



Dubois, M. C., Gentile, N., Laike, T., Bournas, I., & Alenius, M. (2019). *Daylighting and lighting under a Nordic sky*. Studentlitteratur AB.



Ricerca – IEA SHC / EBC

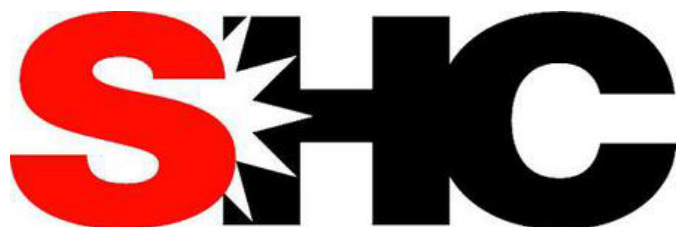


International
Energy Agency

Secure

Sustainable

Together



SOLAR HEATING & COOLING PROGRAMME
INTERNATIONAL ENERGY AGENCY

EBC

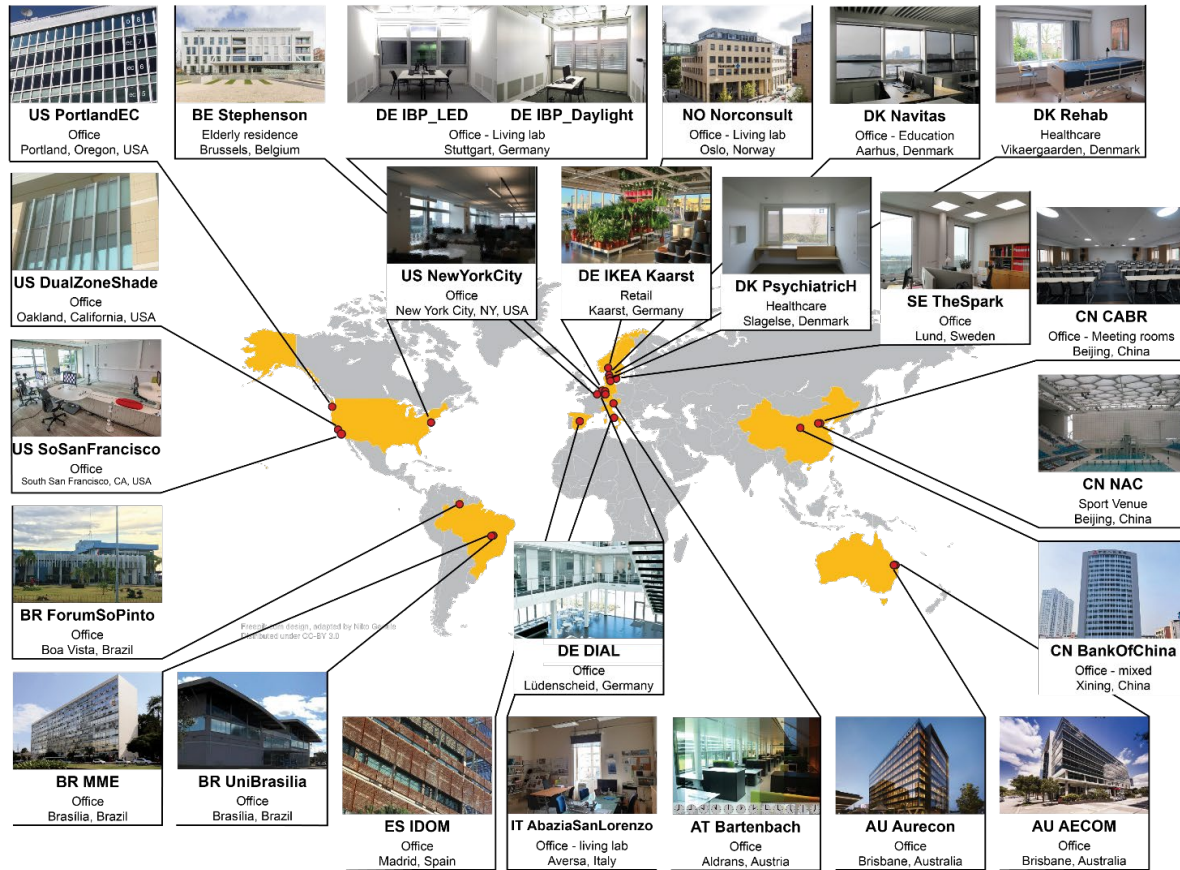


Energy in Buildings and
Communities Programme



Buon design = risparmio

Casi studio IEA SHC Task 60 (2018-2021)



Gentile, N., Lee, E. S., Osterhaus, W., Altomonte, S., Amorim, C. N. D., Ciampi, G., ... & Sibilio, S. (2022). Evaluation of integrated daylighting and electric lighting design projects: Lessons learned from international case studies. *Energy and Buildings*, 268, 112191.



Buon design = risparmio

Casi studio IEA SHC Task 60 (2018-2021)



<https://task61.iea-shc.org/publications>

Gentile, N., Lee, E. S., Osterhaus, W., Altomonte, S., Amorim, C. N. D., Ciampi, G., ... & Sibilio, S. (2022). Evaluation of integrated daylighting and electric lighting design projects: Lessons learned from international case studies. *Energy and Buildings*, 268, 112191.



Buon design = risparmio

Casi studio IEA SHC Task 60 (2018-2021)



- Energy Use Intensity (≈ LENI) minore di 3 kWh/m²a e qualità massima con buon integrazione con luce naturale
- Risultati richiedono buon design, ma anche sistemi di controllo e componenti avanzati
- Più controlli, più materiali, meno sostenibilità?

Gentile, N., Lee, E. S., Osterhaus, W., Altomonte, S., Amorim, C. N. D., Ciampi, G., ... & Sibilio, S. (2022). Evaluation of integrated daylighting and electric lighting design projects: Lessons learned from international case studies. *Energy and Buildings*, 268, 112191.



IEA EBC Annex 90 (2023-2026)

IEA SHC Task 70 / EBC Annex 90

Low Carbon, High Comfort Integrated Lighting

Task Manager: J. de Boer, Germany

Joint Work

Subtask A

*Luo Tao, China
J. de Boer, Germany
(V. Ferreira, Spain)*

**Low Carbon Lighting and
Passive Solar: Scenarios,
Strategies, Roadmaps**

Subtask B

*B. Matusiak, Norway
M. Sarey Khanie, UK*

**Visual and Non-Visual User
Requirements**

Subtask C

*D. Geisler-Moroder, Austria
Eleanor Lee, USA*

**Digitized lighting solutions
(Technology & Design Tools
/ Process)**

Subtask D

*Niko Gentile, Sweden
Natalia G. Vasquez,
Denmark*

**Application and Case
Studies**

Joint Work



IEA EBC Annex 90 (2023-2026)

Research and industry



IEA EBC Annex 90 (2023-2026)

Qualità dell'illuminazione

Tra le sorgenti luminose disponibili, la luce naturale può essere indubbiamente considerata quella di più alta qualità

il che, a volte, porta a «mitizzarla»...



Miti da sfatare

Mito n. 1

“Maggiore accesso alla luce naturale significa risparmio energetico”



Luce naturale e guadagni solari

Facciate in vetro

Fully glazed building in Beijing, near CABR. Image by Niko Gentile

- 
- Consumi elevati per raffrescamento
 - Dispersioni termiche invernali
 - Consumi per illuminazione elettrica...
 - Vantaggi in termini di illuminazione naturale?



La luce naturale va negoziata

Normativa necessita allinamento con EPBD

- Le norme nazionali sono insufficienti per descrivere l'illuminazione naturale
- Lo standard europeo EN17037 é troppo ambizioso e porta a soluzioni in contrasto con i requisiti energetici degli edifici



Miti da sfatare

Mito n. 2

“La luce naturale è gratuita”



Radiazione solare e luce naturale

Efficacia luminosa della luce naturale

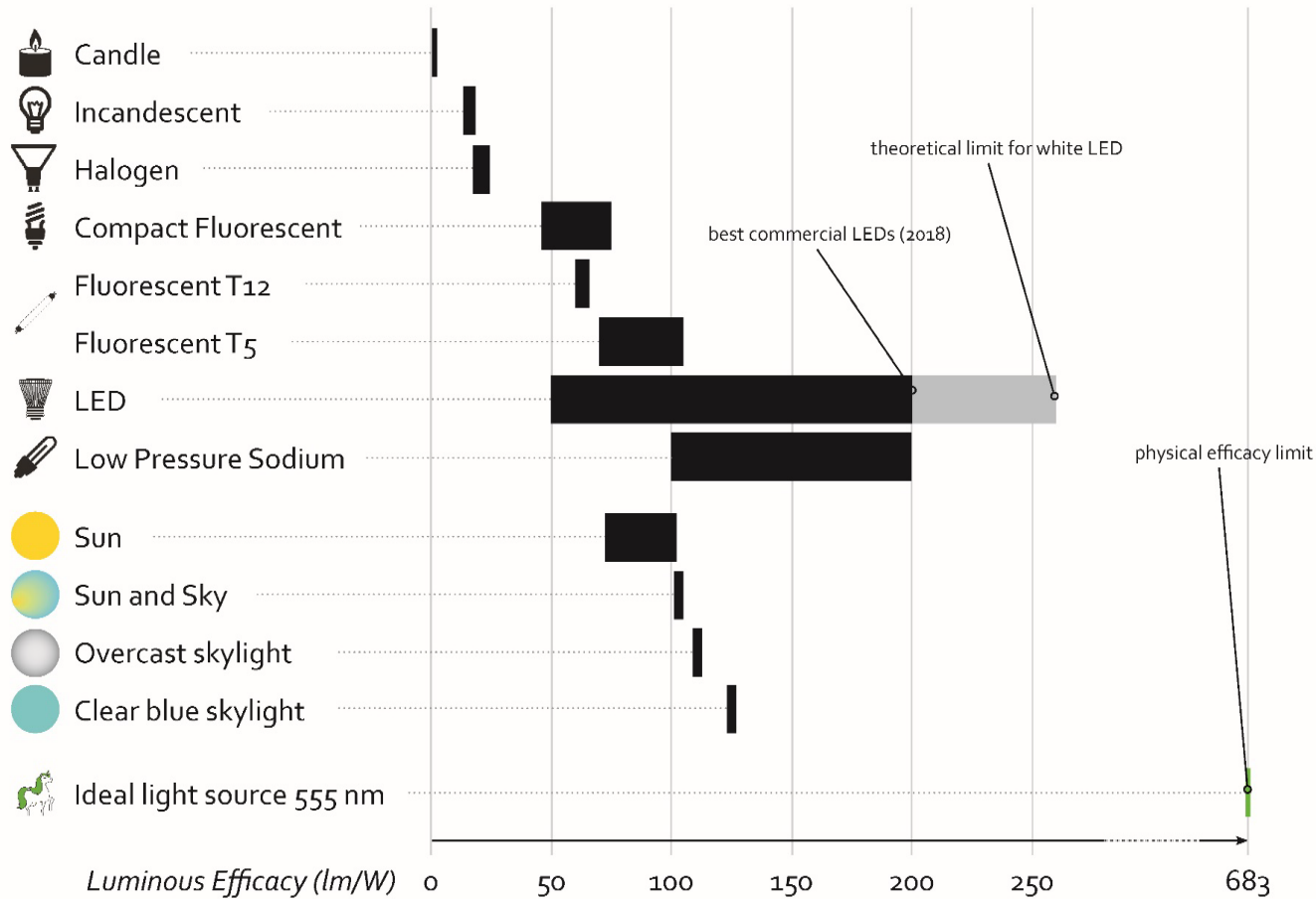
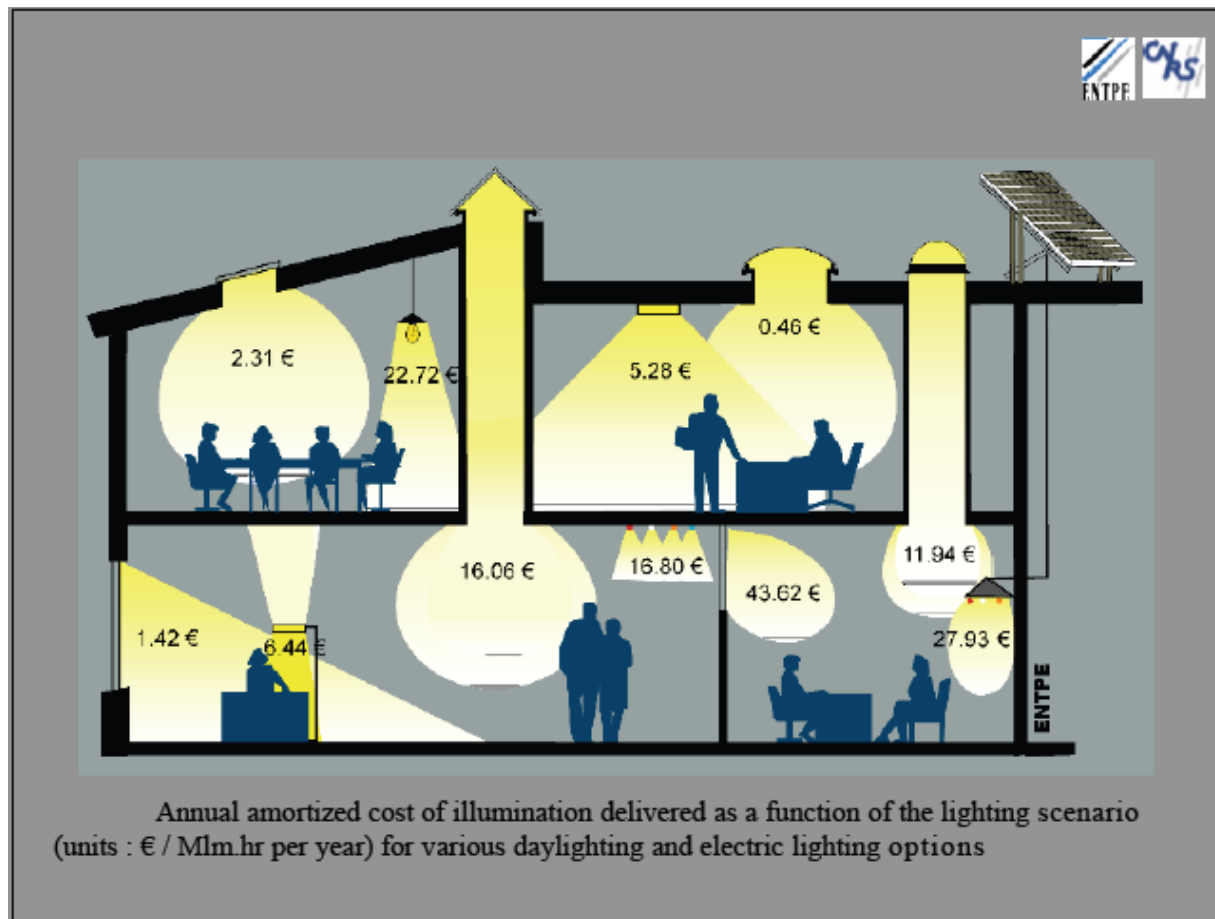


Image by Niko Gentile



Luce naturale

Necessita di componenti che trasportino luce negli interni



Marc Fontoynt, ENTPE, Lyon, France



Luce naturale

Ma la luce naturale é anche un investimento



- Uffici con buon design luce naturale hanno prezzi affitti 5–6% maggiori rispetto ad altri (dati per Manhattan)
- Negozi con luce naturale hanno vendite maggiori, sono più apprezzati dai clienti e trascorrono più tempo al loro interno

Photo: IKEA Kaarst by Rafael Campama Pizarro, Lund University

Turan, I., Chegut, A., Fink, D., & Reinhart, C. (2020). The value of daylight in office spaces. *Building and Environment*, 168, 106503.

Pizarro, RC & Gentile, N 2020, A case study addressing the benefits of daylighting and electric lighting integration in the retail sector. *Proceedings of the ISES Solar World Congress 2019*, Santiago, Chile, pp. 1825-1836
<https://doi.org/10.18086/swc.2019.38.02>



Miti da sfatare

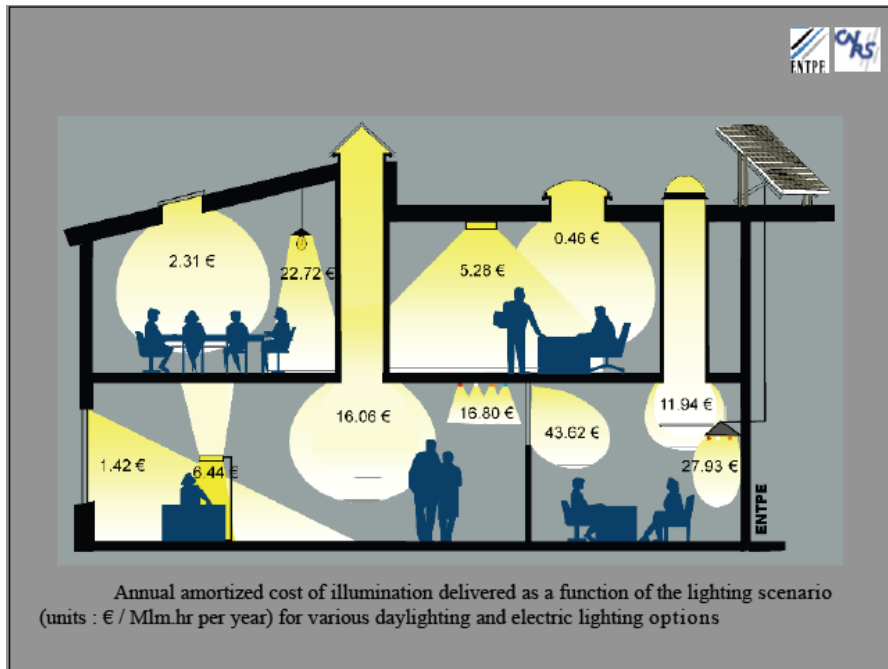
Mito n. 3

“La luce naturale è pulita”



Luce naturale

...e costo ambientale



Ad esempio...

da € / Mlm.hr · yr

a gCO₂e / Mlm.hr·yr

Marc Fontoynt, ENTPE, Lyon, France

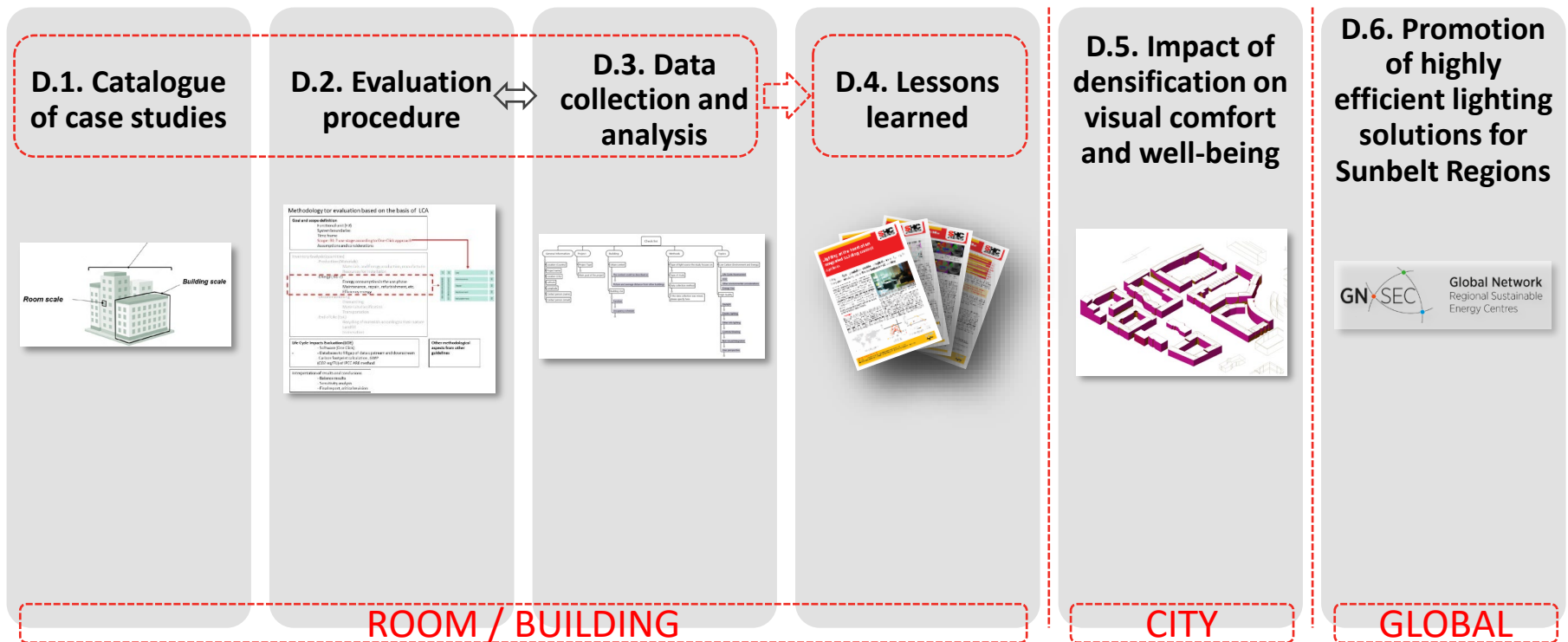


“Soluzioni della più alta qualità ed il minor impatto ambientale”



IEA EBC Annex 90

Azioni dal componente al globale



IEA EBC Annex 90 Subtask D



Valutare impatto componente

Da EPD all'applicazione per supporto decisionale

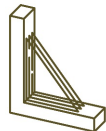


MAIN PROPERTIES

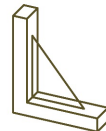
PHYSICAL



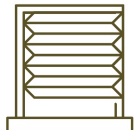
MATERIAL SELECTION



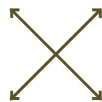
GLAZING TYPE



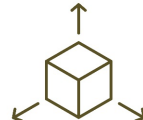
FRAME MATERIAL



SHADING



SIZE



GEOMETRY

PERFORMANCE

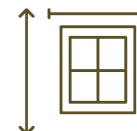


G-VALUE

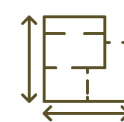


VISUAL
TRANSMITTANCE

BUILDING DEPENDANT



WWR



BUILDING PLAN



SURROUNDING
CONTEXT



BUILDING HEIGHT



ORIENTATION



LOCATION

STATE OF THE ART

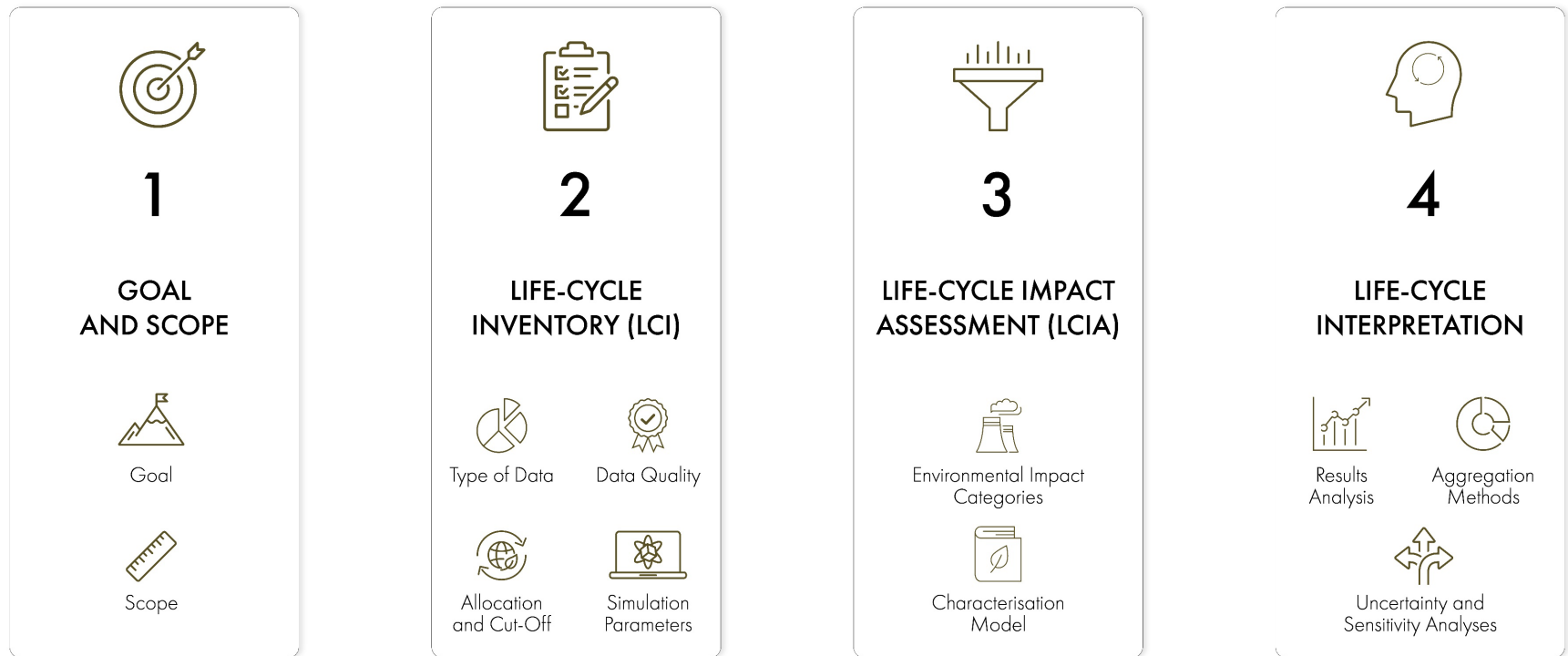
Characteristics Impacting LCA

Ivan Ares Igrexas (2024) A life-cycle approach methodology to evaluate integrated daylight solutions, MSc Thesis, LTH, Lund University <https://lup.lub.lu.se/student-papers/search/publication/9151337>



Valutare impatto componente

Da EPD all'applicazione per supporto decisionale



Structure based on
ISO 14040 and 14044

HARMONISED METHODOLOGY

Structure

Ivan Ares Igrexas (2024) A life-cycle approach methodology to evaluate integrated daylight solutions, MSc Thesis, LTH, Lund University <https://lup.lub.lu.se/student-papers/search/publication/9151337>

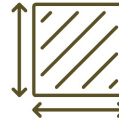


Valutare impatto componente

Da EPD all'applicazione per supporto decisionale

1

GOAL AND
SCOPE



FUNCTIONAL UNIT

kWh of primary energy consumption difference compared to a baseline
in a space with a **minimum Df_m of 1%** over a **50-year period**



HARMONISED METHODOLOGY

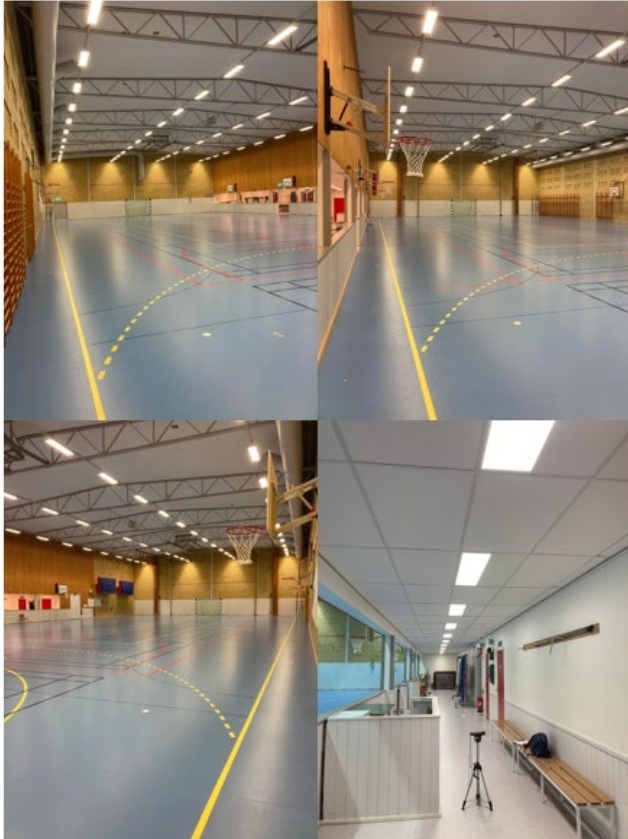
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Luce naturale e sostenibilità

Non tutte le strategie sono ugualmente green



- Tre strategie per introdurre luce naturale in una palestra ad Eslöv, Svezia

Component	Acronym	U-Value (W/(m ² K))	Tvis %	g-value %
Tubular Daylight Device	TDD	0.45	50	30
Skylight	SKL	0.84	72	51
Window	WDW	1.16	72	55

- Tutte garantiscono una discreta qualità dell'illuminazione e consume simili

	TDD	SKL	WDW
DA ₃₀₀ /%	40.10	47.60	51.50
U ₀	0.60	0.65	0.45

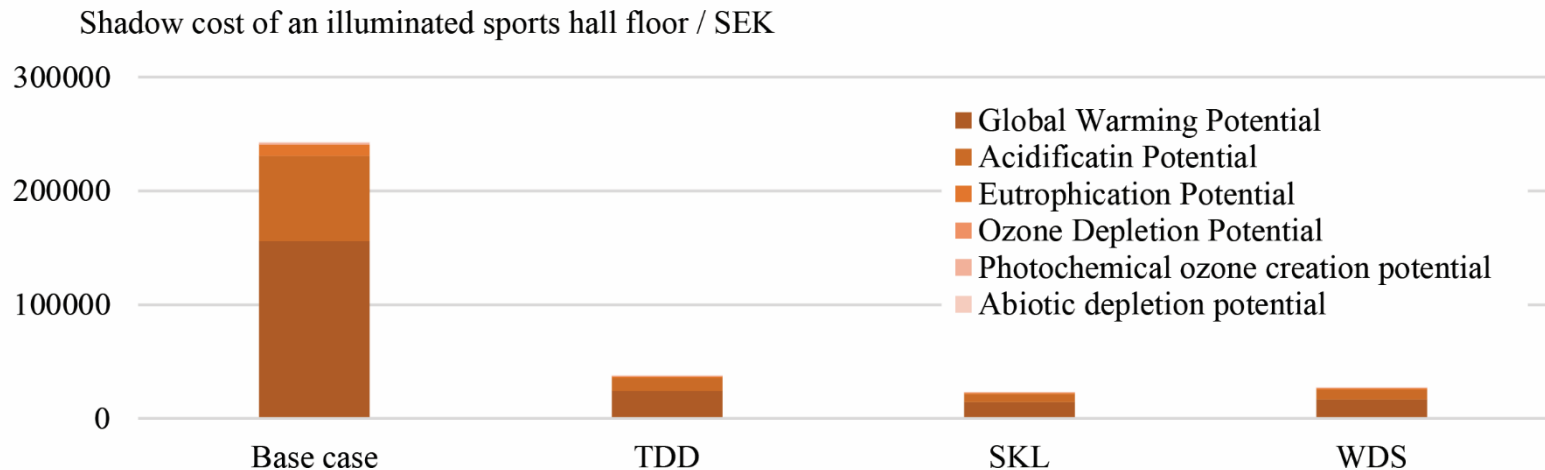
	Base Case	TDD	SL	W
LENI / (kWh/(m ² year))	27.39	15.32	13.82	13.49
Energy-saving / %	-	44.10	49.56	50.74

Carl Laursen and Niko Gentile (2024) Integrated approach to daylighting renovation of a sports hall considering environmental and economic aspects, IBPC 2024, Toronto, Canada. *Accepted for oral presentation*



Luce naturale e sostenibilità

Non tutte le strategie sono ugualmente green



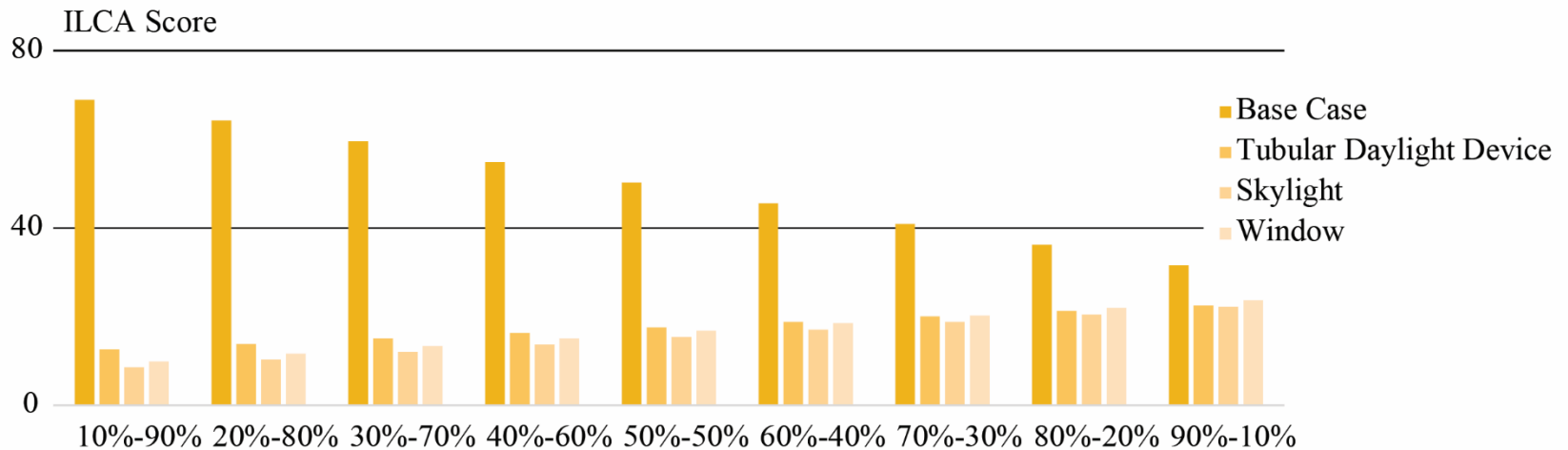
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Luce naturale e sostenibilità

Non tutte le strategie sono ugualmente green

- Integrated Life Cycle Assessment (ILCA): combinazione LCA e LCC
- ILCA più basso = soluzione migliore
- Punteggi normalizzati, e.g. 10%-90% da 10% peso a LCC e 90% a LCA



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Cosa verrà prodotto?

Factsheets per pubblico ampio






LOCATION

Lalöv
SWEDEN



TYPE AND FUNCTION

Room
Sport

LIGHTING FOCUS






TOPICS

Low Carbon



High Comfort

DATA COLLECTION

Simulations

The introduction of skylight, windows, or tubular daylight devices in sports hall can provide both lighting quality and economical return, while reducing the environmental impact of the building.

Daylight in sports halls for lighting quality and lower environmental impact

In this office building, a lighting retrofit with Human Centric Lighting (HCL) system is provided. The HCV can fully change brightness and colour temperature, based on ZPLC (Zero Power Line Communications) technology. It takes less than three months to complete the replacement and commissioning, without changing the original power line. After renovation, the luminous environment was greatly improved, while achieving more than 60% energy saving compared to the previous lighting system.

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Key facts

- Top daylighting guarantees quality and energy savings
- Electric lighting loads can be cut down to almost zero
- Different payback periods for top daylighting solutions

consider top daylighting in sports hall projects

underestimate financial implications

Technology Collaboration Programme

Modelled and simulated by Carl Ljungren and Niko Gentile, Lund University

EA GPC Task 72 / EBC Annex 30
"Low-Carbon High Comfort in expanded Lightlab"

DAYLIGHT IN SPORTS HALLS

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graph LR
    A[Literature review] --> B[Monitoring]
    B --> C[Data acquisition]
    C --> D[Nightlight simulation]
    D --> E[Energy use modeling]
    E --> F[Energy savings electric lighting]
    F --> G[Energy use analysis]
    G --> H[Life cycle cost analysis]
    H --> I[Sensitivity analysis]
    I --> J[Optimize the system analysis]
    J --> K[Optimize the system analysis]
    
```

Figure 1. Overview of the monitoring process, from data acquisition on field to the simulations of scenarios.

Low Carbon

The project is in Xining, the largest city on the Qinghai-Tibet Plateau in China, with an altitude of 2261 meters. It belongs to the typical plateau alpine cold temperature climate, light climate zone II. The Xining Central Sub-branch of the People's Bank of China is an agency of the People's Bank of China. Its main responsibility is to implement the monetary policy formulated by the head office, maintain financial stability, and provide financial services in the Qinghai area. The office building of the People's Bank of China Xining Center Branch is a typical comprehensive office building for financial business.

A balance between financial and environmental requirements

Built in the 1990s, it was once a landmark building in Xining City, Qinghai Province. It has 20 floors and a building area of about 18,000 square meters. The walls are all decorated with natural warm-colour marble, and the decoration style is solemn. After years of operation and use, the lighting facilities are gradually aging, the

lighting is seriously not up to standard, and the energy consumption is high. In 2019, the building underwent a lighting upgrade and renovation. The lighting renovation project is also included in the Chinese "13th Five-Year" national key research and development plan for green buildings and key special technology demonstration projects for building industrialization.

The new building lighting system consists of a completely peer-to-peer distributed network. The system network uses the gateway group as the subnet node. Each subnet can connect to 256 (32 × 8) device, the system network can accommodate up to 64 subnets, and the maximum capacity of the system is 18384 (256×64) devices. The system uses distributed software processing technology to realize the functions of centralized control and management of the lighting system, data storage, and data input and output.

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Figure 2. Top view of the existing sports hall. Neither skylight or windows are installed.

Technology Collaboration Programme
2020

ISA SHC-TS67-7-1-EPB Annex 10
"Low Carbon, High Tech for Improved Lighting"



DAYLIGHT IN SPORTS HALLS

Controls that save energy

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High Comfort

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From fully electric to fully daylight

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Pushing forward circadian potential

Built in the 1950s, it was once a landmark building in Xining City, Qinghai Province. It has 20 floors and a building area of about 18,000 square meters. The walls are all decorated with natural warm-colour marble, and the decoration style is solemn.

"Here a nice quote or a key sentence that you want to highlight"

After years of operation and use, the lighting facilities are gradually aging, the lighting is seriously not up to standard, and the energy consumption is high. In 2019, the building underwent a lighting upgrade and

with natural warm-colour marble, and the decoration style is solemn.



Figure 3 Top view of the scaling sports hall. Neither skyLight or windows are installed

renovation. The lighting renovation project is also included in the Chinese "13th Five-Year" national key research and development plan for green buildings and key special technology demonstration projects for building industrialization.

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Technology Collaboration Programme

EN 1002

EA SP-C-Tes7 T0: EBC, Aarhus, RO
Toscani, Copenhagen, Copenhagen

